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(54) **MULTI-STAGE DIAGNOSTIC SYSTEM AND METHOD**

(71) Applicant: **Innova Electronics, Inc.**, Irvine, CA (US)

(72) Inventors: **Ieon C. Chen**, Laguna Hills, CA (US);
Robert Madison, Lakewood, CA (US);
Michael Nguyen, Norwalk, CA (US)

(73) Assignee: **Innova Electronics, Inc.**, Irvine, CA (US)

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See application file for complete search history.

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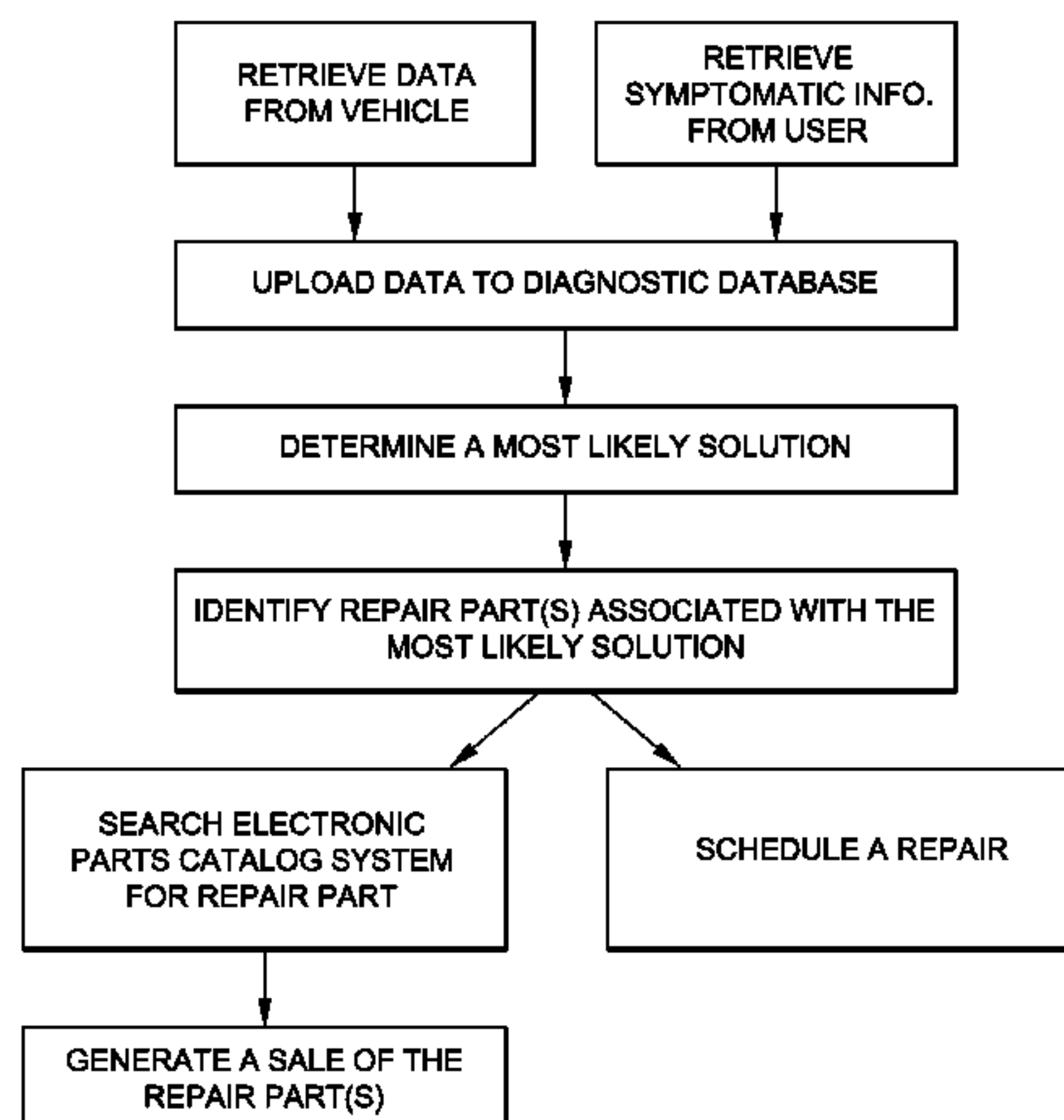
Primary Examiner — Russell Frejd

(74) *Attorney, Agent, or Firm* — Stetina Brunda Garred & Brucker

(57) **ABSTRACT**

A multi-stage diagnostic system and related method which seeks diagnostic information from a secondary information source when a first information source does not yield sufficient data for producing a diagnostic result. In particular, diagnostic process includes a first stage of communicating with an onboard vehicle computer to retrieve diagnostic trouble codes therefrom. If no diagnostic trouble codes are retrieved from the onboard computer, the diagnostic process proceeds to a second stage wherein symptomatic diagnostic information is solicited from the user. A series of symptomatic questions may be presented to the user on a smartphone. The answers from the symptomatic questions may be used to identify a most likely solution, which may be associated with a repair part(s). The corresponding repair part(s) may be identified by an associated universal part number(s) based on vehicle identification information associated with the vehicle needing repair.

20 Claims, 7 Drawing Sheets



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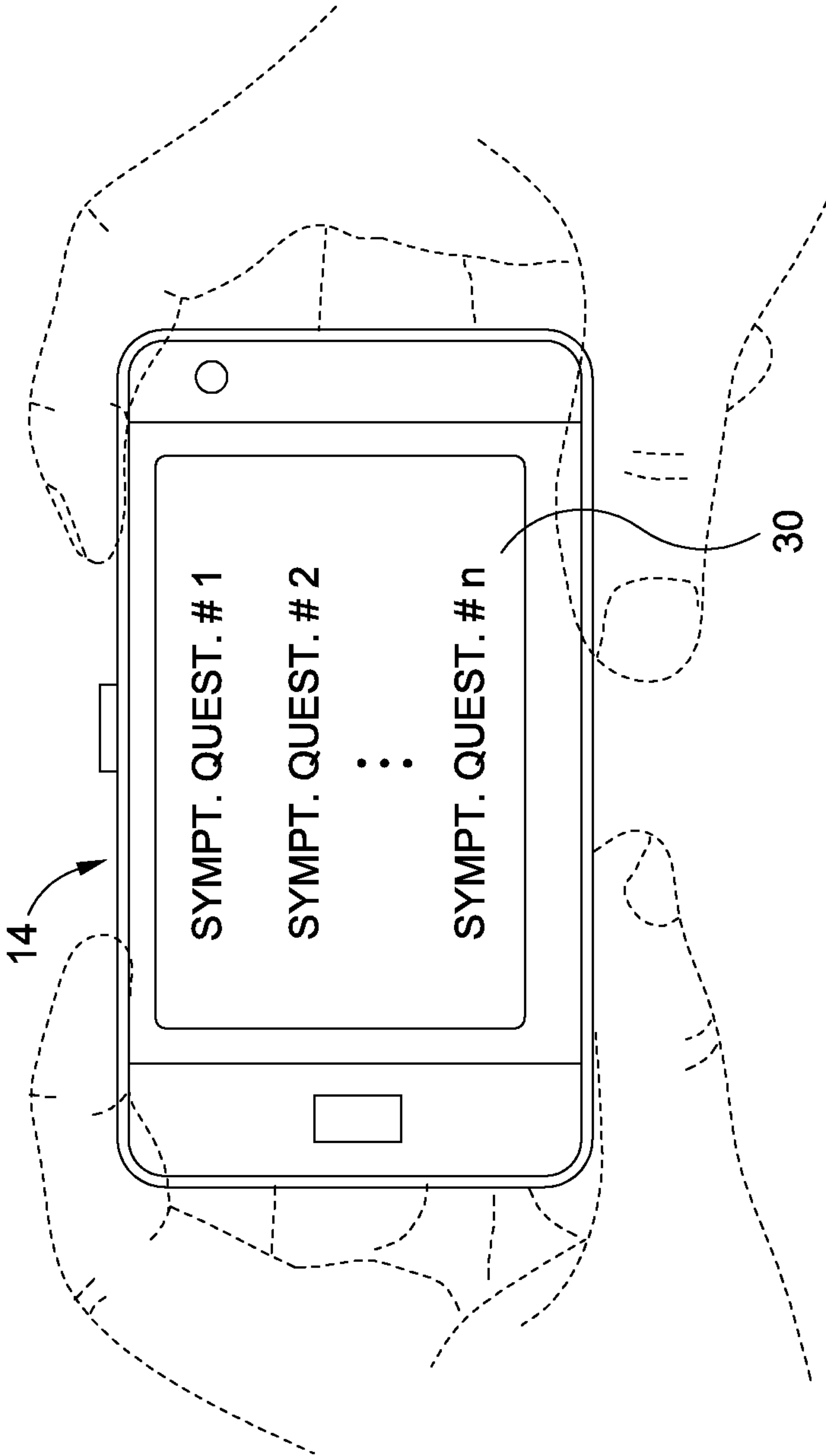


FIG. 2

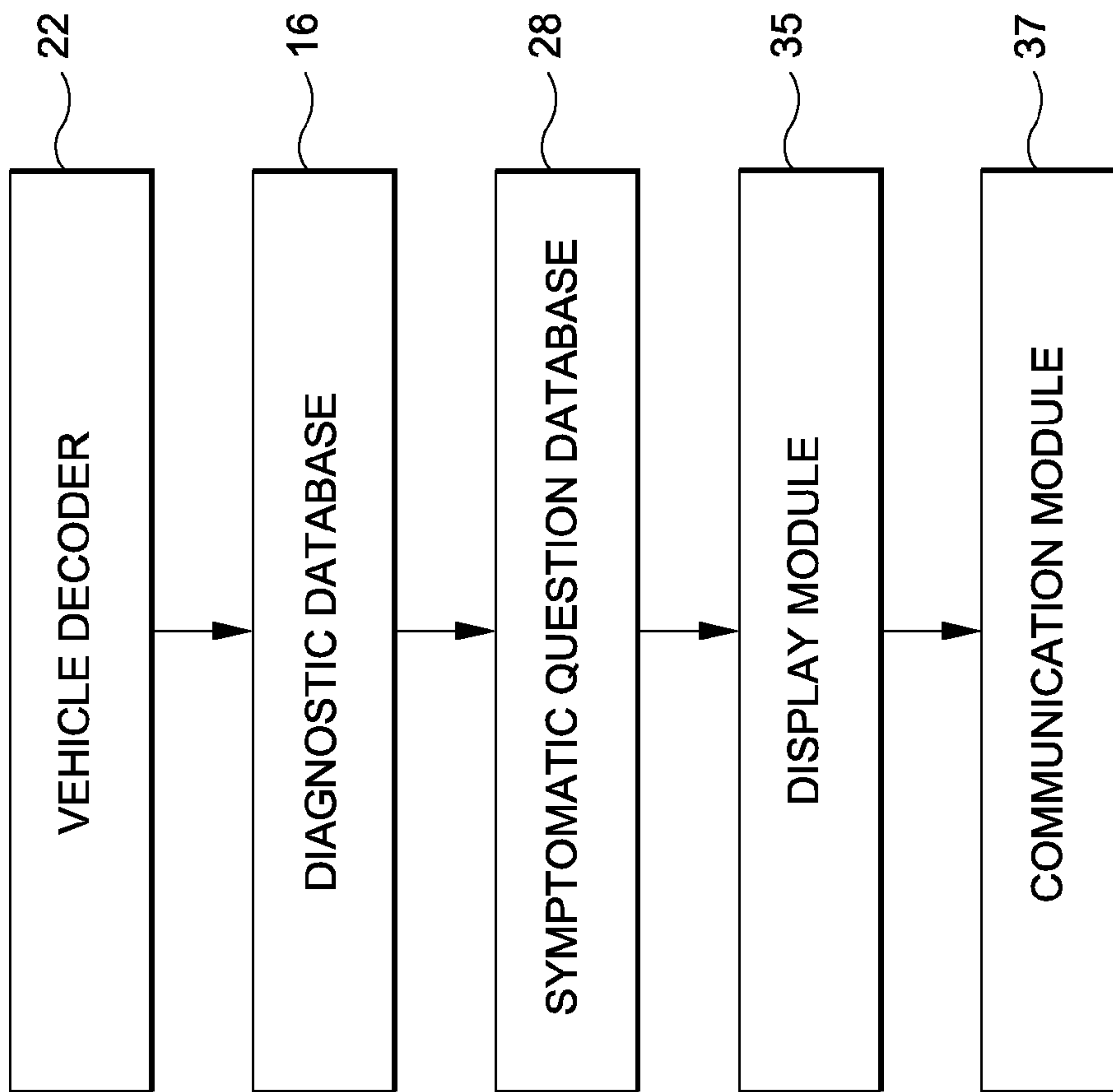


FIG. 3

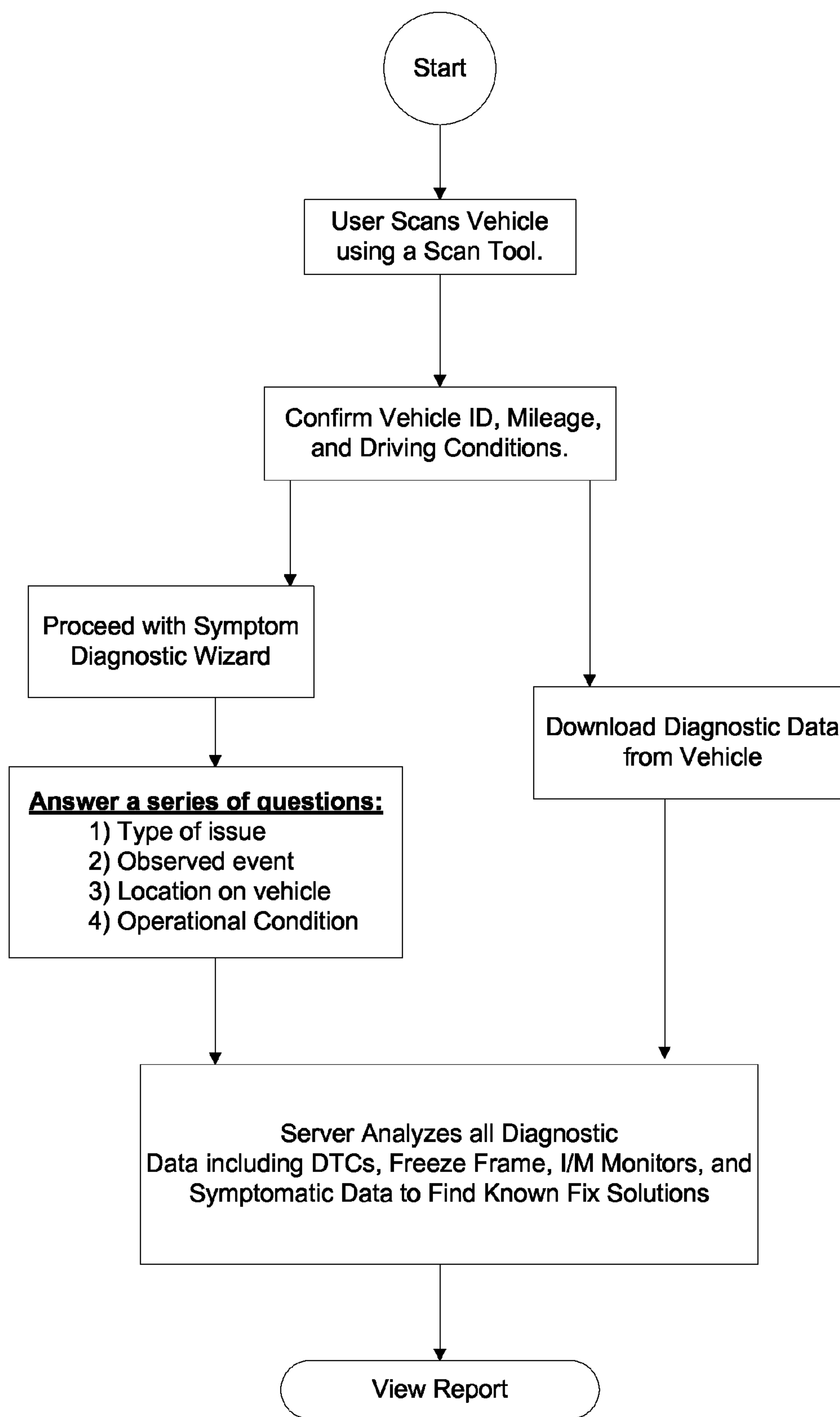


Figure 4

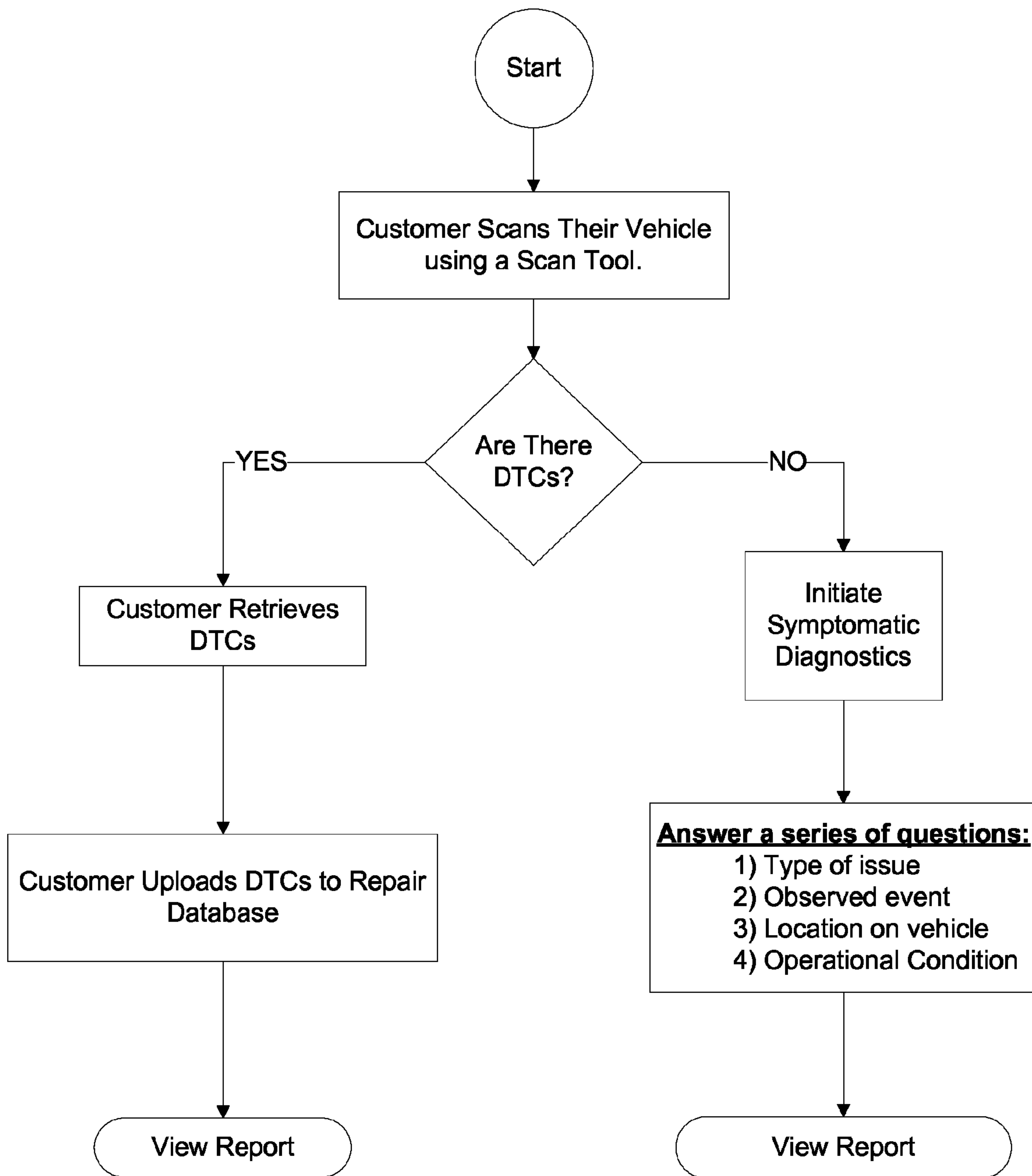


Figure 5

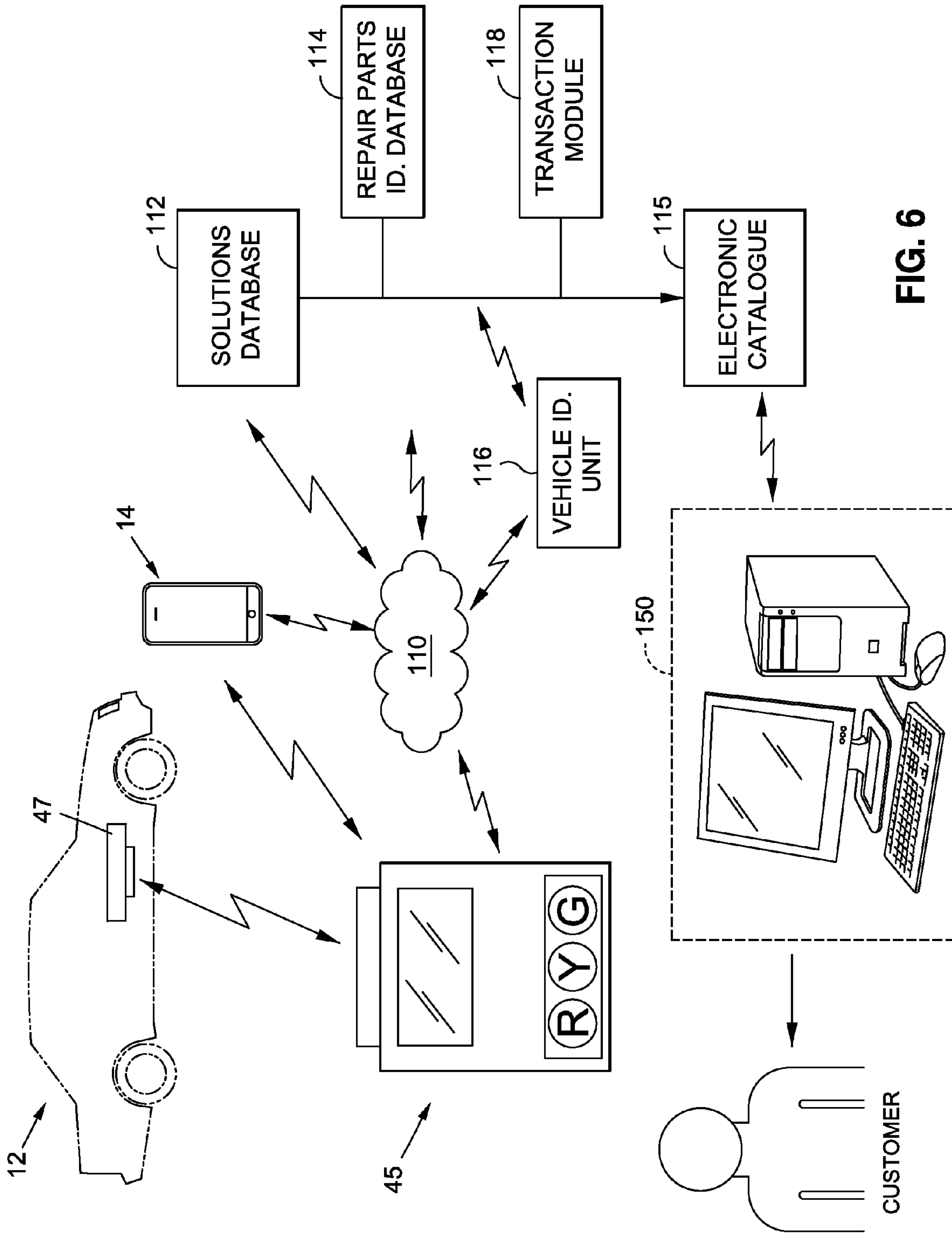


FIG. 6

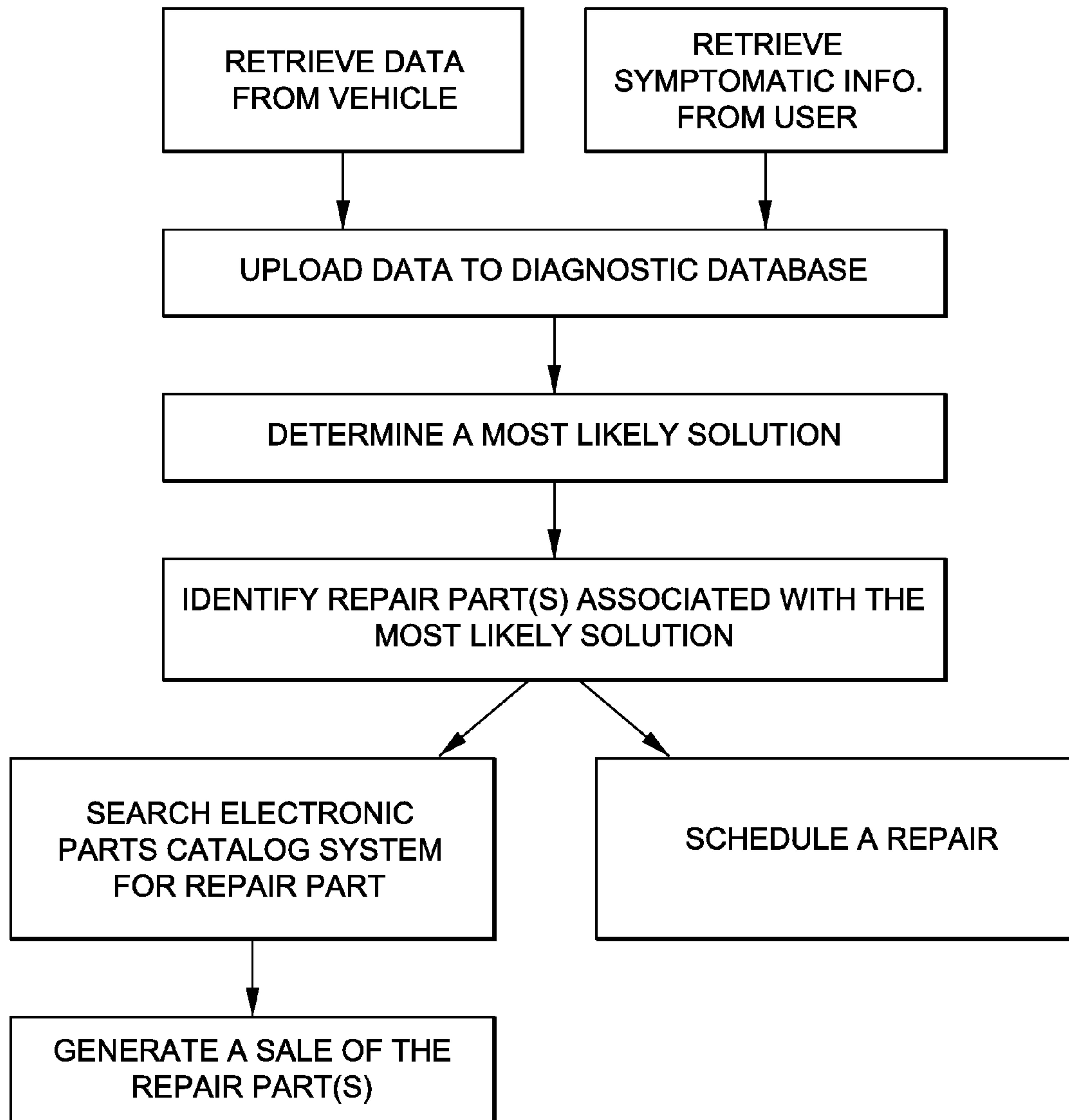


FIG. 7

MULTI-STAGE DIAGNOSTIC SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part application of U.S. application Ser. No. 14/163,691, filed Jan. 24, 2014, now U.S. Pat. No. 9,014,907, which is a continuation-in-part application of U.S. application Ser. No. 13/734,254, filed Jan. 4, 2013, which is now U.S. Pat. No. 8,825,271, the contents of both applications being expressly incorporated herein by reference.

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

The present invention relates to a smart phone application, and more specifically, a smart phone application for facilitating symptomatic diagnosis of a vehicle in response to an indication that there are no diagnostic trouble codes present in an onboard vehicle computer.

2. Description of the Related Art

Automobiles are a common means of transportation in regions throughout the world. In this regard, automobiles may be used for local, day-to-day transportation, or for traveling to more far-reaching destinations.

Automobiles are sophisticated machines comprised of cooperative electrical, mechanical and fluid components. Although automobiles are designed to operate for long periods of time between routine maintenance and checkup, breakdowns may occur at any moment. For those drivers using their automobile for local transportation, a breakdown may be quickly remedied by visiting a local mechanic or repair shop. However, if an automobile breaks down while in a remote location, it may be more difficult to resolve the problem.

For instance, the driver may be required to call an unknown tow-service to have the automobile to a nearby repair shop. Once at the repair shop, the driver is oftentimes in a vulnerable position since the driver cannot diagnose the automobile problem by himself and thus, must rely on the opinion of the mechanic. The mechanic may be misleading as to the true nature of the problem, as well as the cost associated with fixing the problem.

Various devices have been developed to arm the driver with objective diagnostic information regarding the health of their vehicle. For instance, diagnostic scan tools are devices which typically connect with an onboard vehicle computer to retrieve diagnostic trouble codes therefrom. The diagnostic trouble codes may be uploaded to a diagnostic database for analysis for determining a possible diagnostic solution.

Although such devices are typically powerful automotive diagnostic tools, drivers oftentimes do not have access to diagnostic equipment when a vehicle breaks down. For instance, one family may own one diagnostic scan tool for use with several vehicles, such that if any of the vehicles not including the diagnostic scan tool breaks down, the tool may not be available as a resource.

Recognizing this deficiency, there is a need in the art for a diagnostic system which utilizes equipment readily accessible to a driver, should a breakdown occur. One device commonly carried or kept in close proximity to many individuals

is a smart phone, which is a handheld electronic device capable of communicating over a cellular telephone network. Smart phones are also typically include data processing and display capabilities, which allows smart phones to be used for a wide range of functions beyond simply making phone calls.

Therefore, there is a need in the art for an automotive diagnostic system which utilizes the capabilities smart phone to retrieve symptomatic information from a user/driver and upload such information to a diagnostic database. As described below, the present invention addresses these and other improvements to contemporary vehicle authentication and diagnostic prediction systems.

BRIEF SUMMARY OF THE INVENTION

There is provided a multi-stage diagnostic system and related method which seeks diagnostic information from a secondary information source when a first information source does not yield sufficient data for producing a diagnostic result. In particular, diagnostic process includes a first stage of communicating with an onboard vehicle computer to retrieve diagnostic trouble codes therefrom. If diagnostic trouble codes are received from the onboard computer, the diagnostic trouble codes are used to produce a diagnostic result. On the other hand, if no diagnostic trouble codes are retrieved from the onboard computer, the diagnostic process proceeds to a second stage wherein symptomatic diagnostic information is solicited from the user. A series of symptomatic questions may be presented to the user on a hand held electronic device (e.g., smartphone, tablet computer, etc.).

According to one embodiment, there is provided a system for providing diagnostics for a vehicle having an onboard computer using a hand held electronic device. The system includes a scan tool disposable in operative communication with the onboard computer for retrieving diagnostic trouble codes therefrom. The system further includes a diagnostic database having diagnostic solutions matched with symptomatic data. A set of computer executable instructions is downloadable onto the hand held computing device for configuring the hand held electronic device to: establish communication between the hand held electronic device and the scan tool, display a symptomatic question sequence for the user when there is no diagnostic trouble code received from the onboard computer, store symptomatic data received from the user, and communicate the symptomatic data to the diagnostic database. The diagnostic database is configured to match symptomatic data received from the hand held electronic device with a diagnostic solution.

The symptomatic question sequence may include a first question and a second question, wherein the content of the second question depending on user input received in response to the first question.

The computer executable instructions may additionally configure the hand held electronic device to display a symptomatic question sequence that is customized in accordance with vehicle identification information associated with the vehicle. The scan tool may be configured to retrieve vehicle identification information from the onboard computer. The vehicle identification information may include a vehicle identification number or license plate information.

The computer executable instructions may further configure the smart phone to receive information associated with the diagnostic solution from the diagnostic database, and display the information associated with the diagnostic solution. The information associated with the diagnostic solution includes a cost of repair statement. The computer executable instruc-

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tions may further configure the hand held electronic device to establish wireless communication with the scan tool.

The system may additionally include a hand held electronic device configured to retrieve vehicle identification information from the vehicle. The hand held electronic device may include a camera configured to capture an image or video of a portion of the vehicle, wherein the hand held electronic device is loaded with a set of executable instructions effect to derive the vehicle identification information from the captured image or video. The camera may also include a microphone for capturing sound associated with operation of the vehicle. The hand held electronic device may include a smart phone.

The diagnostic database may be located on the hand held computing device, or alternatively, on a computer server.

The system may also include a repair parts database in operative communication with the diagnostic database, wherein the repair parts database includes repair parts associated with most likely solutions, vehicle identification information, and universal part numbers. The diagnostic database may be configured to identify a most likely solution based on symptomatic data received from the handheld communication device. The repair parts database may be configured to identify a repair part(s) associated with an identified most likely solution and suitable for use on a vehicle identified by the vehicle identification information, the repair part(s) being identified by an associated universal part number(s). The universal part number(s) may be Aftermarket Catalog Enhanced Standard (ACES) part numbers.

According to another aspect of the invention, there is provided a set of computer executable instructions downloadable onto the hand held computing device for configuring the hand held electronic device to: display a symptomatic question sequence for the user in response to an indication that there is no diagnostic trouble code identified as being present in the onboard computer, store symptomatic data received from the user, and communicate the symptomatic data to the diagnostic database.

The present invention is best understood by reference to the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

These as well as other features of the present invention will become more apparent upon reference to the drawings wherein:

FIG. 1 is a schematic overview of an embodiment of a smart phone based vehicle verification and predictive diagnostic system;

FIG. 2 is a schematic view of a smart phone listing a series of symptomatic questions;

FIG. 3 is a schematic view of an embodiment of a symptomatic diagnostic smart phone application for use with a smart phone;

FIG. 4 is a flow chart of a method using diagnostic data and symptomatic data in combination with each other to determine a diagnostic solution;

FIG. 5 is a flow chart of a multi-staged diagnostic process according to an embodiment of the present invention;

FIG. 6 is a schematic view of an automotive diagnostic system in accordance with another embodiment of the present invention; and

FIG. 7 is a flow chart for an automotive diagnostic method in accordance with the system depicted in FIG. 6.

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Common reference numerals are used throughout the drawings and detailed description to indicate like elements.

DETAILED DESCRIPTION OF THE INVENTION

The detailed description set forth below is intended as a description of the presently preferred embodiment of the invention, and is not intended to represent the only form in which the present invention may be constructed or utilized. The description sets forth the functions and sequences of steps for constructing and operating the invention. It is to be understood, however, that the same or equivalent functions and sequences may be accomplished by different embodiments and that they are also intended to be encompassed within the scope of the invention.

Referring now to the drawings, wherein the showings are for purposes of illustrating a preferred embodiment of the present invention only, and are not for purposes of limiting the same, there is shown a symptomatic diagnostic system **10** for diagnosing a vehicle **12** using vehicle identification information, such as the vehicle identification number (VIN) or license plate information, to generate vehicle specific symptomatic questions for display on the user's smart phone **14**. The symptomatic question sequence may vary from vehicle to vehicle, and may be developed based on historical diagnostic records for similar vehicles. In this regard, the symptomatic questions sequence is "intelligent" insofar as the questions may be vehicle-specific and may be based on continually-updated historical diagnostic records. The symptomatic questions may be displayed on the smart phone **14** and the user may enter the answers to the symptomatic questions into the smart phone, which may upload the answers to a remote diagnostic database **16** or a customer service center **18**. The user's answers may be used to determine a probable diagnosis and to identify a most likely fix to the probable diagnosis.

The smart phone based system **10** provides vehicle specific diagnostic support in isolated and remote locations. For instance, if a user is experiencing vehicle problems while on a long road trip, the user may utilize the system **10** to obtain advanced diagnostic support without having to visit a mechanic's garage or repair shop. In this regard, the advanced diagnostic support may be accessible wherever the user's smart phone can communicate with the remote diagnostic database **16** and/or customer service center **18**. Moreover, if the user does visit a mechanic, the user may be armed with the objective assessment obtained from the diagnostic system **10** to keep the mechanic honest.

Referring now specifically to FIG. 1, there is shown an embodiment of the vehicle-specific symptomatic diagnostic system **10** which utilizes the smart phone **14** as a central hub of information. As used herein, the term "smart phone" may refer to a handheld electronic device having an input, a display and the capability of communicating over a wireless communication network. Exemplary smart phones include the Apple iPhone®, the RIM Blackberry®, and the Galaxy Nexus®. It is also contemplated that the term "smart phone" may encompass tablet computers, such as the Apple iPad® or the Microsoft Surface®, or other handheld electronic devices known by those skilled in the art.

The smart phone **14** is used to optically capture vehicle identification information associated with the vehicle **12**. Those skilled in the art will readily appreciate that most smart phones **14** include a camera **20**. The camera **20** is used to capture an image of vehicle identification information associated with the vehicle, such as the VIN **15** or license plate **19**. The VIN may be displayed in various locations throughout the vehicle, such as under the windshield or in the door panel.

It is also contemplated that the VIN may be associated with a bar code **17** attached to the vehicle. The camera **20** may capture an image of the bar code **17** or scan the bar code **17** to decode the bar code **17** to obtain the VIN. The camera **20** may also capture a video of the vehicle **12** to allow for identification thereof, as well as sound associated with operation of the vehicle **12**.

It is also contemplated that in other embodiments, the vehicle identification information may be manually entered into the smart phone **14**. In yet another embodiment, the smart phone **14** may be disposable in wireless communication with an onboard vehicle computer to receive vehicle information therefrom. For instance, the onboard vehicle computer may emit a wireless signal including the electronic VIN associated with the vehicle **12**.

After the vehicle identification information is obtained by the smart phone **14**, the vehicle identification information is uploaded to a vehicle decoder **22** to determine vehicle characteristic information based on the vehicle identification information. The vehicle characteristic information may include, but is not limited to the vehicle year, make, model, and engine type.

According to one embodiment, the vehicle decoder **22** is located remotely from smart phone **14** such that the image of the vehicle identification information is communicated from the smart phone **14** to the remote vehicle decoder **22** via wireless communication means, such as via a cellular telephone network. For instance, the remote vehicle decoder **22** may be located on a server **23**, a personal computer **27**, or other remote computing devices. In another embodiment, the vehicle decoder **22** is stored locally on the smart phone **14**, in which case, the vehicle identification information may be communicated from the camera **20** to the vehicle decoder **22** within the smart phone **14**. The vehicle decoder **22** may extract or determine information based on a photograph of the vehicle's VIN **15** or license plate **19**. For instance, the vehicle decoder **22** may identify the specific alphanumeric characters included in the image of the VIN **15** or license plate, which in turn may be used to determine the vehicle characteristic information.

In one embodiment, the vehicle decoder **22** is a VIN decoder **24** which derives vehicle characteristic information from the vehicle's VIN. In this regard, the various alphanumeric characters included in the VIN may be used to determine the vehicle characteristic information. The VIN decoder **24** may include a VIN decoding database or lookup table which vehicle characteristic information correlated to alphanumeric characters included in the VIN. In another embodiment, the vehicle decoder **22** is a license plate decoder **26** and derives the vehicle characteristic information from the license plate. In this regard, the license plate decoder **26** may have access to one or more government databases having stored vehicle characteristic information correlated with license plate information.

Once the vehicle characteristic information is determined by the vehicle decoder **22**, a signal including the vehicle characteristic information is sent to the symptomatic question database **28**. The symptomatic question database **28** includes symptomatic questions organized according to vehicle characteristic data. For instance, the symptomatic questions for a 2008 HONDA ACCORD® may differ from the symptomatic questions for a 2008 TOYOTA CAMRY®. Thus, the symptomatic questions may be vehicle specific, depending on the year, make, model, engine type or other vehicle characteristic.

As used herein, "symptomatic questions" are questions which may be presented to the user to diagnose a potential

vehicle problem based on a user's characterization of vehicle symptoms or defects. The symptomatic question sequence may include a comprehensive, multi-level series of questions which become more specific based on the user's answers. In this regard, the symptomatic questions may be presented to the user to trouble-shoot the vehicle problems based on questions answered by the user.

The symptomatic question sequence may begin with simple, closed-ended questions presented in a multiple choice format. For instance, a general question which may be initially asked to the user may be: "What appears to be the nature of the problem? A) Mechanical or B) Electrical." If the user selects "A) Mechanical," a series of follow up questions may include, "What type of symptom(s) are you experiencing? A) Irregular Smell, B) Irregular Sound, C) Irregular Sight (i.e., smoke), D) Irregular Feel (i.e., vibration)." "Where is the irregular sound coming from? A) Front—Driver's Side, B) Front—Passenger's Side, C) Rear—Driver's Side, D) Rear—Passenger's Side." "When do you hear the sound? A) When the car is in park, B) When the car is moving." "Does the sound occur when you press the brakes? A) Yes, B) No." Those skilled in the art will readily appreciate that the questions presented above are exemplary in nature only and are not intended to limit the scope of the present invention.

The answers selected by the user may be stored in the smart phone **12** and then uploaded to the remote diagnostic center **16**. The answers may be matched with databases at the remote diagnostic center **16** and/or may be reviewed by diagnostic personnel, i.e., mechanics, to determine a possible diagnostic solution.

The symptomatic questions may be derived from historical information related to vehicle fixes for vehicle sharing similar vehicle characteristic information. In particular, the content of the symptomatic questions and the order of the symptomatic questions may be arranged based on historical data. According to a preferred implementation of the present invention, the symptomatic questions are updated in the database **28** by a network of mechanics or automotive professionals based on their experience in diagnosing vehicles having certain vehicle characteristics.

The symptomatic question(s) are communicated from the symptomatic question database **28** to the smart phone **14** for display on the smart phone display **30** (see FIG. 2). In one embodiment, the questions are downloaded onto the smart phone **14** for display on the smart phone **14**, while in another embodiment, the questions are hosted on a website accessible by the smart phone **14**.

The symptomatic questions sequence may be static, i.e., wherein the content and sequence of questions are generated irrespective of the user's answers, or dynamic, i.e., wherein the content and/or sequence of questions are generated in response to the user's answers. In other words, the symptomatic question sequence may include at least a first question and a second question, wherein the content of the second question depends on user input received in relation to the first question.

According to one embodiment, the symptomatic question database **28** is located remote from the smart phone **14**. It is contemplated that the symptomatic question database **28** may store vast amounts of data and require routine updating, and thus, it may be beneficial to have the symptomatic question database **28** located remote from the smart phone **14**, which may not have the internal capacity to store such large amounts of data. For instance, the symptomatic question database **28** may be located on the server **23**, personal computer **27**, or other remote computing devices. However, it is contemplated

that other embodiments may include a symptomatic question database **28**, or at least a portion thereof, that is stored locally within the smart phone **14**. Along these lines, once the vehicle characteristic information is determined, information from the symptomatic question database **28** corresponding to the vehicle characteristic information may be downloaded to the smart phone **14**.

The symptomatic questions are displayed on the smart phone display **30** and the user answers the questions using the smart phone input device(s). In this regard, the user's answers may be entered via a touch screen or keypad. It is also contemplated that the smart phone **14** may be configured to detect verbal answers from the user. The user's answers to the symptomatic questions will be referred to herein as "symptomatic data."

The symptomatic data received by the user is communicated to the diagnostic database **16**, which includes diagnostic solutions matched with symptomatic data. The diagnostic database **16** is organized according to vehicle characteristic information. In this regard, the diagnostic database **16** matches the symptomatic data received from the smart phone **14** with a diagnostic solution corresponding to the vehicle characteristic information of the vehicle under consideration. The diagnostic database **16** may be located remotely from the smart phone **14**, such as on the server **23**, the personal computer **27**, or other remote computing devices. Alternatively, the diagnostic database **16** may be located on the smart phone **14**.

According to one embodiment, the functions executed by the smart phone **14** may be implemented by computer executable instructions (i.e., a smart phone application or app.) which are downloadable onto the smart phone **14**. Referring now specifically to FIG. **3**, there is shown a schematic view of an embodiment of the smart phone app. which is downloadable onto the smart phone **14**. In the exemplary embodiment, the smart phone app. includes the vehicle decoder **22**, diagnostic database **16**, symptomatic question database **28**, a display module **35**, and a communications module **37**. Those skilled in the art will readily appreciate that the smart phone app. shown in FIG. **3** is exemplary in nature only and that not all embodiments of the smart phone app. may include all of the components depicted in FIG. **3**. Furthermore, additional components may be added to the smart phone app. without departing from the spirit and scope of the present invention.

It is also contemplated that the computer executable instructions may configure the smart phone **14** to perform other functions. For instance, the smart phone may be able to extract/determine vehicle identification information from a photograph of the VIN or license plate. The determined vehicle identification information may be used by the vehicle decoder **22** to derive the vehicle characteristic information.

The smart phone app. may further configure the smart phone **14** to receive the diagnostic solution from the diagnostic database **16** and display the diagnostic solution on the smart phone display **30**. Once the diagnostic solution is displayed, the user may take appropriate action to either implement the diagnostic solution or seek help from a mechanic.

It is contemplated that the various aspects of the present invention are related to determining a diagnostic solution based solely on the symptomatic data provided by the user. However, other aspects of the invention relate to utilizing diagnostic data retrieved from the vehicle, along with the symptomatic data, to determine the diagnostic solution. In this respect, the diagnostic data retrieved from the vehicle may include, but is not limited to, DTCs, freeze frame data, live data, I/M monitors, battery condition information, or other data known or later developed in the art. An exemplary

process of using diagnostic data received from the vehicle, e.g., DTCs, in combination with symptomatic data is illustrated in the flowchart shown in FIG. **4**. In this regard, the vehicle diagnostic data may be used to verify a diagnostic solution derived solely from symptomatic data, or the vehicle diagnostic data may be used in conjunction with the symptomatic data to determine the best or most likely diagnostic solution from a list of possible diagnostic solutions.

Accordingly, in one embodiment, the smart phone app. configures the smart phone **14** to receive vehicle diagnostic data and upload the vehicle diagnostic data to the diagnostic database **16**. The vehicle diagnostic data may be communicated from a code reader **45**, which communicates with the vehicle ECU **47**. The code reader **45** may have the communication capabilities to poll the vehicle ECU **47** to determine the proper communication protocols for retrieving information from the ECU **47**. The code reader **45** may also have storage capabilities to store the protocol information, as well as diagnostic data retrieved from the vehicle. Vehicle data retrieved by the code reader **45** may be communicated to the smart phone **14**, preferably by wireless communication. In this regard, the code reader **45** may have a built-in wireless communication circuit, or alternatively, the code reader **45** may be configured to be connectable with a wireless communication adapter for wirelessly communicating vehicle data to the smart phone **14**. It is also contemplated that the code reader **45** may be configured to communicate the vehicle data retrieved from the ECU **47** via wired communication means. Although the code reader **45** is configured to communicate information to the smart phone **14**, various embodiments of the code reader **45** are configured to operate independent of the smart phone **14**. In this regard, the code reader **45** may poll the ECU **47**, retrieve diagnostic data from the ECU **47**, store the data, and upload data to the diagnostic database **16** independent of the smart phone **14**.

Certain embodiments of the code reader **45** may be more sophisticated and include a user interface including a local display for displaying diagnostic data (i.e., diagnostic trouble codes, freeze frame data, live data, etc.) retrieved from the vehicle. The user interface may also include a user input(s) for allowing a user to make selections or navigate through information. In another embodiment, the code reader **45** is less sophisticated and does not include a user interface, and simply includes the capability to interface the smart phone **14** with the vehicle ECU **47**. In this regard, a less sophisticated code reader **45** would have the capability to communicate with the ECU **47**, store vehicle data, and upload that data to the smart phone **14**.

Any information retrieved by the code reader **45** and communicated to the smart phone **14** may be uploaded to the diagnostic database **16**, which may be configured to receive the diagnostic data and make a diagnostic determination based on the vehicle diagnostic data and the symptomatic data. As indicated above, the code reader **45** may operate independent of the smart phone **14**, and retrieve and upload data to the database **16** independent of the smart phone **14**. In this regard, according to one embodiment the smart phone **14** is simply used to display symptomatic questions and retrieve symptomatic data from the user, and upload the symptomatic data to the database **16**. The symptomatic questions may be initiated by the user (i.e., opening the app.) or alternatively, the database **16** may communicate a signal to the smart phone **14** to initiate the symptomatic questioning in response to receipt of diagnostic information from the code reader **45**.

The code reader **45** may also be able to retrieve an electronic VIN from the vehicle ECU **47**, wherein the electronic

VIN may be used to determine the vehicle characteristic information, as described in more detail above.

Although one feature of the present invention relates to determining a diagnostic solution based, at least in part, on symptomatic data, one step in the diagnostic process is to determine vehicle characteristic information. It is contemplated that once the vehicle characteristic information is determined, additional information which may be useful to the user may be easily obtained. For instance, in one embodiment, the vehicle characteristic information may be used to make a diagnostic prediction of the vehicle. More specifically, the diagnostic predication may include a summary of likely failures or repairs for the vehicle, and the mileage at which those failures or repairs will likely occur. Thus, the predictive diagnostic feature may provide the user with an estimate as to the health of the vehicle and the cost for operating and maintaining the vehicle in the future. For a more comprehensive discussion on predictive diagnostics, please refer to U.S. patent application Ser. No. 13/589,532, entitled Predictive Diagnostic Calculation, owned by Innova Electronics Inc. of Irvine, Calif., and the contents of which are expressly incorporated herein by reference.

The diagnostic prediction feature includes a defect predictor **40** which compares the vehicle characteristic data (i.e., the determined year, make, model, etc.) associated with the vehicle with information in a historical defect database **42** to make the diagnostic prediction. The diagnostic prediction may be summarized as being a LOW, MEDIUM or HIGH probability of failure, and may relate to the vehicle as a whole, or a particular component, within a certain mileage range.

The defect database **42** includes information related to defects that have occurred in different vehicles and the reference mileage at which such defects occurred. The defector predictor **40** is in communication with the vehicle decoder **22** and the defect database **42** and is configured to identify defects listed in the defect database **42** corresponding to vehicles having similar characteristic information to the vehicle.

According to one embodiment, the defect database **42** includes the reference mileage associated with each identified associated defect. In this regard, the smart phone app may further configure the smart phone to prompt the user to enter the mileage of the vehicle and communicate the entered mileage to the defect predictor **40**. The defect predictor **40** may be further configured to restrict the identified defects to defects that have occurred within a mileage bracket that substantially corresponds to the current mileage of the vehicle.

For more information related to defect prediction, please see U.S. patent application Ser. No. 13/569,522 entitled Smart Phone App-Based Method and System of Collecting Information for Purchasing Used Cars, filed Aug. 8, 2012 and owned by Innova Electronics Inc. of Irvine, Calif., and whose contents are expressly incorporated herein by reference.

Although the foregoing describes many of the functionalities of the symptomatic diagnostic system as being implemented on a smart phone app., it is also contemplated that the functionalities may be hosted by a website **25** accessible by the smart phone **14** or any other computing device. In this regard, the website **25** may host the vehicle decoder **22**, the diagnostic database **16**, and the symptomatic question database **28**. Information may be communicated between the website **25** and the smart phone **14** via a cellular telephone network. Information received by the smart phone **14** from the website **25**, such as the symptomatic questions, may be displayed on the smart phone **14**. Furthermore, information

received by the website **25** from the smart phone **14** may be analyzed and processed by the servers or databases hosting the website **25**.

According to other embodiments of the present invention, and there is provided multi-staged diagnostic process which initially attempts to determine a diagnostic solution based on diagnostic trouble codes retrieved from the vehicle's onboard computer **47**. FIG. **5** is a flowchart illustrating the multi-staged process, wherein the first stage proceeds when diagnostic trouble codes are present in the onboard computer **47**, and the second stage proceeds when diagnostic trouble codes are not present in the onboard computer. In the second stage, symptomatic information is retrieved from the user and is analyzed to determine a diagnostic result. Thus, the absence of diagnostic trouble codes serves as a trigger for displaying the symptomatic question sequence. In this regard, the multi-staged diagnostic process allows a user to continue the diagnostic process when the user is experiencing problems with their vehicle, despite the absence of diagnostic trouble codes retrieved from the onboard computer **47**.

The first stage of the process is a conventional diagnostic process wherein a scan tool **45** is placed in communication with the vehicle's onboard computer **47** to retrieve diagnostic trouble codes therefrom. When diagnostic trouble codes are received from the onboard computer **47**, the diagnostic trouble codes are uploaded to a diagnostic database **16**, which matches the trouble codes with a diagnostic solution. The diagnostic database **16** may be located remote from the scan tool **45**, and thus, the scan tool **45** may be in communication with the diagnostic database **16** via an onboard communications circuit capable of communicating with the diagnostic database, or the scan tool **45** may be placed in communication with an intermediate device, such as a computer, smart phone, tablet computer, or the like, which is capable of receiving the information from the scan tool **45** and uploading the information to the diagnostic database **16**.

The diagnostic database **16** receives the diagnostic trouble codes, analyzes the codes, and returns a diagnostic solution. For a more detailed discussion regarding the analysis of diagnostic trouble codes, please refer to U.S. Pat. No. 8,019,503, entitled Selective Access Process, and U.S. Pat. No. 8,370,018, entitled Method of Ranking Automotive Repair Solutions Associated with Automotive Diagnostic Data, both of which are owned by Innova Electronics Inc., and the contents of which are expressly incorporated herein by reference.

According to one embodiment, when no diagnostic trouble codes are received from or present in the onboard computer **47**, the diagnostic process continues to a second stage, wherein symptomatic information is retrieved from a user via a hand held electronic device **14**. Along these lines, it is understood that certain diagnostic conditions may not trigger a diagnostic trouble code, yet may cause drivability issues. The symptomatic information retrieved from the user may be useful for diagnosing the cause of the drivability issue. Therefore, while many conventional diagnostic processes would stop when no diagnostic trouble codes are retrieved from the onboard computer **47**, various aspects of the present diagnostic process include a second stage which utilizes symptomatic information from the user to determine a diagnostic solution.

As used herein, the term "hand held electronic device" may refer to a smart phone, tablet computer, scan tool or similar hand held electronic devices having a display for displaying symptomatic questions to the user, as well as a user input to allow the user to enter symptomatic information into the hand held electronic device.

A set of computer executable instructions are downloaded onto the hand held computing device **14** for configuring the

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hand held electronic device **14** to perform a variety of functions. The computer executable instructions may include a smartphone application that is available for download from an application store or marketplace, such as the Apple App Store™. The computer executable instructions may be tailored for various operating systems, such as iOS™ by Apple™, the Android™ operating system, or other operating systems used by other hand held electronic devices, such as scan tools.

According to one embodiment, the computer executable instructions allow the hand held electronic device **14** to establish communication between the hand held electronic device **14** and the scan tool **45**. Preferably, the communication between the hand held electronic device **14** and the scan tool **45** is wireless communication, although the communication may be wired communication without departing from the spirit and scope of the present invention.

The computer executable instructions further configure the hand held electronic device **14** to display the symptomatic question sequence for the user in response to an indication that there are no diagnostic trouble codes identified as being present in the onboard computer **47**. Such an indication may include a signal sent from the scan tool **45** that the onboard computer **47** has been scanned, and that no diagnostic trouble codes were received from the onboard computer. In another implementation of the invention, the hand held electronic device **14** may be configured to communicate directly with the onboard computer **47**, and thus, the hand held electronic device **14** may receive a signal directly from the onboard computer **47** that no diagnostic trouble codes are presently stored therein.

The symptomatic question sequence may relate to a variety of topics, such as the type of drivability issue experienced by the driver, the observed symptoms, the location of the vehicle, and the operational condition of the vehicle. Along these lines, the symptomatic question sequence may include a first question and a second question, wherein the content of the second question depending on user input received in relation to the first question. The symptomatic question sequence may be tailored to vehicle identification information associated with the vehicle (such as the VIN), or alternatively, the symptomatic question sequence may be more generic in nature. For a more detailed discussion of the symptomatic question sequence, please refer to the foregoing discussion.

The computer executable instructions further configure the hand held electronic device **14** to store the symptomatic data received from the user, and communicate the symptomatic data to the diagnostic database **16** or customer service center **18**, as described above. In this regard, the hand held electronic device **14** may have communication capabilities which allow the device **14** to communicate with the diagnostic database **16**. For instance, in the case of a smartphone, the smartphone **14** may communicate with a remotely located diagnostic database **16** via a wireless communication network.

As discussed in more detail above, the diagnostic database **16** includes diagnostic solutions matched with symptomatic data, wherein the diagnostic database **16** is configured to match symptomatic data received from the hand held electronic device with a diagnostic solution. After a diagnosis has been made, the diagnostic result may be communicated to the hand held electronic device **14** for display thereon.

The foregoing describes a diagnostic system which includes a scan tool **45** for scanning the vehicle's onboard computer, and a hand held electronic device **14** for retrieving symptomatic information from the user, communicating the symptomatic information to a diagnostic database **16** and displaying the diagnostic result. In this regard, the above-

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described system does not rely on the scan tool **45** for display or long-range communication capabilities (i.e., the ability to communicate with the diagnostic database **16**), and instead relies on the hand held electronic device for such capabilities.

However, it is contemplated that other embodiments of the diagnostic system include a scan tool **45** which also performs the functionalities described above as being associated with the hand held electronic device **14**. Along these lines, the scan tool **45** may include a dedicated display screen capable of displaying the symptomatic question sequence and the diagnostic results. Furthermore, the scan tool **45** may also include a user input which allows a user to enter symptomatic information. In addition, the scan tool **45** may be capable of communicating with the diagnostic database **16**. For instance, the scan tool **45** may include a WiFi module that allows the scan tool **45** to upload the symptomatic information via Internet through a locally accessible WiFi network. In that instance, a separate smartphone or tablet computer may not be needed.

The foregoing discussion primarily relates to determining a possible diagnostic solution based on symptomatic information provided by the user, information retrieved from the vehicle, or a combination thereof. The following discussion relates to identification of replacement or repair parts associated with the most likely solution.

Referring now to FIG. **6**, there is shown an automotive diagnostic system specifically configured and adapted to more easily identify a repair part for a vehicle **12**, wherein the repair part is associated with the most likely solution. A diagnostic device **45** (e.g., code reader, scan tool, data logger, dongle, etc.) is connected to the onboard vehicle computer **47** to retrieve data and information therefrom, as described above. The diagnostic device **45** shown in FIG. **6** is a dongle which is connected to the OBD-II port on the vehicle **12** for communicating with the onboard computer **47**. In this respect, the term "diagnostic device" is used herein to broadly refer to unsophisticated devices (e.g., a dongle) which simply retrieve and transfer data, to more sophisticated devices (e.g., scan tools) having onboard diagnostic processing and display capabilities.

The data retrieved from the vehicle **12** may include diagnostic data, such as DTCs, freeze frame data, battery condition information, e.g., dead battery, low voltage, no start, no charge, etc. and other data commonly retrieved from the onboard computer **47**, in addition to vehicle identification information. The battery condition information may be received from the on-board vehicle computer **47**, or may be derived from the voltage levels received (or not received) from the vehicle **12**. For instance, if the voltage level is above a first threshold, the battery may be considered to be in a good or normal condition. If the voltage level is lower than the first threshold, but above a second threshold, the battery level may be considered to be low. Furthermore, if the diagnostic device **45** receives no voltage from the vehicle **12** when connected thereto, the battery may be considered to be dead or have no charge.

The vehicle identification information may include the vehicle identification number (VIN) or alternatively the year, make, model, and engine type of the vehicle. The diagnostic data and vehicle information retrieved from the onboard computer may be analyzed locally on the device **45** or uploaded to a communications network **110**. The uploading of diagnostic data and vehicle information may be facilitated through the use of an intermediate communication device, such as a smartphone, tablet computer, personal computer or other intermediate communication devices known, or later developed, by those skilled in the art. Furthermore, the communication net-

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work **110** may include the Internet, a telephone communication network, a local area network, or other communication networks known in the art.

The system further includes a smart phone **14** which may be used to collect symptomatic data from the user, as described in more detail above. The smart phone **14** may also be used for relaying communication between the diagnostic device **45** and the communication network **110**, and as such, the smart phone **14** may be in operative communication with the diagnostic device **45**, either by way of wireless communication (e.g., Bluetooth™, WiFi, etc.) or wired communication.

The symptomatic data and/or the diagnostic data may be communicated to a solution database **112** from the communication network **110**. The solution database **112** is configured to match the symptomatic and/or diagnostic data with stored solutions to identify a most likely solution that is associated with the uploaded symptomatic and/or diagnostic data. In some cases, the most likely solution may be as simple as ensuring that the gas cap is properly secured to the vehicle. In other cases, the most likely solution will require a repair part. For instance, the most likely solution may be that a mass airflow sensor needs to be replaced.

When the most likely solution involves a repair part, the most likely solution is communicated to a repair parts identification database **114**, which includes repair parts organized according to the most likely solution and the vehicle identification information. The repair part may also be matched with a universal part identification number. An example of a universal parts identification system is the Aftermarket Catalog Enhanced Standard (ACES) parts numbering system, although other universally accepted parts identification systems may also be used in connection with the present invention without departing from the spirit and scope of the present invention.

The repair part identified by the solutions database **112** may be matched with the parts listed in the repair parts identification database **114** to determine the universal part number associated with the repair part. It is understood that a given part (e.g., a mass airflow sensor) may vary from one vehicle to the next. Accordingly, there may be several universal part identification numbers associated with the different mass airflow sensors. As such, in order to identify a specific mass airflow sensor that is adapted for use with a specific vehicle, vehicle identification information is required. Thus, the repair parts identification database **114** may receive that vehicle identification information as part of the upload from the tool **1**. Alternatively, the repair parts identification database **114** may receive a universal vehicle identification number from a vehicle identification unit **116**.

It is also contemplated that in addition to parts being assigned universal identification numbers, vehicles may also be assigned a universal vehicle identification number, which corresponds to vehicles having the same year, make, model, and engine type. Thus, once a vehicle **12** has been identified, the specific parts used on that vehicle **12** may also be identified. Consequently, each universal vehicle identification number will be associated with various universal part identification numbers. When the vehicle **12** under consideration has been identified, the universal part numbers associated with the vehicle **12** may be focused on to simplify the analysis.

The diagnostic methods described herein may be useful in various e-commerce applications. For instance, when the system identifies a most likely defect and/or a repair part or procedure associated with the most likely defect, the system may take steps to quickly effectuate the repair. One particular

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aspect of the system is that certain steps in the overall process may proceed automatically, without any input from the user, thereby reducing the burden on the user.

The system may also be configured to search one or more online databases to find prices for repair parts or services associated with a particular ACES part number. For instance, the cost for a particular part associated with a particular part number may be collected from a host of different retailers. Furthermore, the service for installing the part may also be collected from a host of different service locations/repair shops. The collected prices may be displayed on the user's computer, smartphone or other display device to allow the user to select which vendor to complete the sale.

According to one embodiment, diagnostic data (e.g., DTCs, Freeze Frame data, battery condition information, etc.) may be automatically uploaded from the device **45** to a diagnostic database, such as the solution database **112**. The upload of diagnostic data may be completed through the use of an intermediate device, such as the smart phone **14**, or the tool **45** may include onboard hardware capable of uploading the information directly. The data may be uploaded in response to a command entered by the user (e.g., the user actuating a button on the device **45** or a linked device, such as a smartphone), or in response to a predefined triggering condition. For instance, the device **45** may be associated with a particular parts store **150** such that when the vehicle **12** (having the device **45** plugged into the vehicle **12**) enters a predefined area around the parts store **150**, such as the parking lot, the device **45** automatically uploads the information to the diagnostic databases **112** associated with the parts store **150**. The triggering condition is not limited to the device **45** moving into a predefined area around the parts store **150**. Rather, the predefined triggering condition may also include one of the following: the smart phone **14** initiating a symptomatic question sequence for the user, the smart phone **14** uploading symptomatic information to the solutions database **112**, the device **45** being in wireless communication with a predefined wireless network (e.g., public or private Internet access), the device **45** moving into a predefined area around a service garage, the device **45** returning home or to a garage, the engine being turned ON, the engine being turned OFF, a DTC being generated by the vehicle. Of course, those skilled in the art will appreciate that the aforementioned triggering conditions are exemplary in nature only, and are not intended to limit the scope of the present invention. Along these lines, other triggering conditions known in the art may also be used without departing from the spirit and scope of the present invention.

Once symptomatic information and/or the information from the vehicle **12** is uploaded to the diagnostic databases **112**, a most likely solution is determined, along with a corresponding repair part. As with the upload of information to the database **112**, the analysis of the diagnostic information at the database **112** may be completed automatically without input from the user, and potentially without the user being aware of the process implementation.

According to one embodiment, the system may automatically complete the sale of the repair part to expedite the repair if certain conditions are met. For instance, the user may only want to purchase the part if the associated most likely defect is critical. Conversely, if the part is associated with a non-critical defect, the user may be prompted for authorization to complete the sale of the part.

The process of completing the sale of the repair part may include establishing a link between the diagnostic database **112** and an electronically searchable parts catalog or database **115** to determine if the parts store **150** carries the specific

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repair part needed (e.g., the repair part associated with the specific part number), if the repair part is in stock, as well as determining the price of the repair part. The search of the parts database 115 may be completed automatically without any input from the user. It is contemplated that a plurality of parts databases 115 associated with different parts stores may be searched to find the nearest repair part and/or the least expensive repair part. A transaction module 118 may be in communication with the repair parts identification database 114 and an electronic catalogue 115 associated with the parts store 150 for effectuating the sale.

The system may be configured to automatically ship the part to the user to allow the user to complete the repair. Alternatively, the part may be set aside for the user at the parts store for pickup. In other embodiments, the sale of the part may not be completed until the user arrives at the store. The user may be sent part tracking information to enable quick and easy completion of the sale once the user arrives at the store. For instance, the system may send an email and/or text message to the user with a reference number, tracking number, bar code, or other transaction identification information to simplify the sale when the user arrives at the store. The part information may also be displayed for the customer at the parts store to allow the customer to visually confirm the information prior to purchase.

In addition to automatically generating a sale of the part, the system may also automatically schedule a repair to install the new repair part. The automatic scheduling of the repair may be particularly useful in fleet management applications. When a repair is automatically scheduled, the user/fleet manager may be sent a message with details associated with the repair, such as the date/time of the repair, estimate time to complete the repair, cost of the parts/service, etc.

Additional modifications and improvements of the present invention may also be apparent to those of ordinary skill in the art. Thus, the particular combination of components and steps described and illustrated herein is intended to represent only certain embodiments of the present invention, and is not intended to serve as limitations of alternative devices and methods within the spirit and scope of the invention.

What is claimed is:

1. A system for providing diagnostics for a vehicle having an onboard computer and vehicle identification information using a handheld communication device, the system comprising:

- a scan tool disposable in operative communication with the onboard computer for retrieving vehicle data therefrom;
 - a diagnostic database having most likely solutions matched with diagnostic data;
 - a repair parts database in operative communication with the diagnostic database, the repair parts database having repair parts associated with most likely solutions and vehicle identification information; and
 - a set of computer executable instructions downloadable onto the handheld communication device for configuring the handheld communication device to:
 - establish communication between the handheld communication device and the scan tool;
 - display a symptomatic question sequence for the user when the vehicle data does not include a preset condition;
 - store symptomatic data received from the user; and
 - communicate the symptomatic data to the diagnostic database;
- the diagnostic database being configured to identify a most likely solution based on symptomatic data received from the handheld communication device;

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the repair parts database being configured to identify a repair part(s) associated with the identified most likely solution and suitable for use on a vehicle identified by the vehicle identification information, the identified repair part(s) being identified by an associated universal part number(s).

2. The system recited in claim 1, wherein the associated universal part number(s) in the repair parts database are Aftermarket Catalog Enhanced Standard (ACES) part numbers.

3. The system recited in claim 1, wherein the computer executable instructions further configure the handheld communication device to display a symptomatic question sequence that is customized in accordance with vehicle identification information associated with the vehicle.

4. The system recited in claim 1, wherein the scan tool is configured to retrieve vehicle identification information from the onboard computer.

5. The system recited in claim 1, further comprising a camera configured to capture an image of a license plate or a vehicle identification number and wherein the set of executable instructions configure the handheld communication device to derive the vehicle identification information from the captured image.

6. The system recited in claim 1, wherein the vehicle identification information includes a vehicle identification number.

7. The system recited in claim 1, wherein the vehicle identification information includes license plate information.

8. The system recited in claim 1, further comprising a computer server, wherein the diagnostic database is located on the computer server.

9. The system recited in claim 1 wherein the symptomatic question sequence includes a first question and a second question, the content of the second question depending on user input received in response to the first question.

10. The system recited in claim 1, wherein the computer executable instructions further configures the handheld communication device to:

- receive information associated with the most likely solution from the diagnostic database; and
- display the information associated with the identified most likely solution.

11. The system recited in claim 1, wherein the information associated with the most likely solution includes a cost of repair statement.

12. The system recited in claim 1, wherein the computer executable instructions configure the handheld communication device to establish wireless communication with the scan tool.

13. The system recited in claim 1, wherein the computer executable instructions configure the handheld communication device to display the symptomatic question sequence for the user when diagnostic trouble codes are received from the onboard computer, the diagnostic database being configured determine the most likely solution based on an evaluation of diagnostic trouble codes and symptomatic data.

14. The system recited in claim 1, wherein the preset condition includes there being no diagnostic trouble code received from the vehicle.

15. The system recited in claim 1, wherein the preset condition is when the battery voltage is below a preset voltage level.

16. An automotive diagnostic system for use with a vehicle having an onboard computer and vehicle identification information using a handheld communication device, and a diag-

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nostic tool configured to retrieve diagnostic data from the onboard computer, the automotive diagnostic system comprising:

a symptomatic database having symptomatic questions associated with vehicle identification information, the symptomatic database being configured to send symptomatic questions for display on the handheld communication device in response to receipt of the vehicle identification information from the handheld communication device;

a diagnostic database having most likely solutions matched with symptomatic data, the diagnostic database being configured to identify a most likely solution in response to receipt of symptomatic data from the handheld communication device; and

a repair parts database in operative communication with the diagnostic database, the repair parts database having repair parts associated with the identified most likely solution, the vehicle identification information and universal part numbers, the repair parts database being configured to identify a repair part(s) associated with the identified most likely solution and suitable for use on a

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vehicle identified by the vehicle identification information, the identified repair part(s) being identified by an associated universal part number(s).

17. The automotive diagnostic system recited in claim 16, wherein the associated universal part numbers in the repair parts database are Aftermarket Catalog Enhanced Standard (ACES) part numbers.

18. The automotive diagnostic system recited in claim 16, wherein the diagnostic database is configured to determine the most likely solution based on an evaluation of diagnostic trouble codes and symptomatic data.

19. The automotive diagnostic system recited in claim 16, wherein the symptomatic database is configured to generate a symptomatic question sequence that is customized in accordance with vehicle identification information associated with the vehicle.

20. The automotive diagnostic system recited in claim 19, wherein the symptomatic question sequence includes a first question and a second question, the content of the second question depending on user input received in response to the first question.

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